Report 11318
10 November 1998

Integrated Advanced Microwave Sounding Unit-A (AMSU-A)

Engineering Test Report

AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August/September 1998 (S/O 565632, OC-417) Plus Addendum A

Contract No. NAS 5-32314
CDRL 207

Submitted to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Submitted by:

Aerojet
1100 West Hollyvale Street
Azusa, California 91702

GENCORP
AEROJET

INTEROFFICE MEMO

TO: L. T. Paliwoda

DATE: 10-Nov-1998
a1vib-sn202.doc
170:8411#98-604

FROM: R. J. Heffner

SUBJECT: AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August 1998 (S/O 565632, OC-417)

COPIES TO: J. .A. Alvarez, D. H. Brest, D. B. Chi, R. V. Hauerwass, D. L. Tran, Writer, File

REFERENCES:

1 "Advanced Microwave Sounding Unit-A1 (AMSU-A1) Instrument Assembly EOS Qualification Level Vibration Testing", Shop Order 565632 (OC-417), July 1998.
2. "EOS/AMSU Assy, A1", Dwg. 1356008.
3. "Vibration and Sine Burst Qualification and Acceptance Test Procedure for the AMSU-A System", Aerojet Process Specification AE-26151/1C, 1 July 1998.
4. "Failure Review Board (FRB) Meeting Held 8/07/98 (F/AR 133)", IOM 6060/98#596, Channel 7 Degradation, E. J. Lorentz.
5. "Test Report - AMSU-A1 Engineering Model Reflector Response Tests", Report No. 10418, February 1994.

PURPOSE

The purpose of this memo is to present a summary of the qualification level vibration testing performed on the S/N 202 AMSU-A1 Ref. 2 Instrument during the August 1998 time frame.

SUMMARY

The Ref. 2, S/N 202, EOS AMSU-A1 Instrument was vibration tested to qualification levels per the Ref. 1 shop order. The instrument withstood the 8g sine sweep test, the 7.5 Grms random vibration test, and the 18.75g sine burst test in each of the three orthogonal axes. Some loss of transmissibility, however, is seen in the lower reflector after Z-axis random vibration.

The test sequence was not without incidence. Failure of Channel 7 in the Limited Performance Test (LPT) performed after completion of the 1st (X-axis) axis vibration sequence, required replacement of the DRO and subsequent re-testing of the instrument. The post-vibration comprehensive performance test (CPT) was successfully run after completion of the three axes of vibration with the replacement component installed in the instrument. Passing the CPT signified the successful completion of the S/N 202 A1 qualification vibration testing.

DISCUSSION

EOS qualification level testing was performed on the S/N 202 A1 assembly during the month of August, 1998. Due to failure of a channel (Channel 7) on the Limited Performance Test (LPT) performed after completion of the first (X-axis) axis vibration test sequence, a Failure Review Board (FRB) was assembled, resulting in the Ref. 4 plan. The 2nd axis (Y-axis) vibration sequence was run with the suspect Channel 7 without incident. However, the post Y-axis vibration LPT showed further degradation of the Channel 7 signal. At this time, vibration testing was stopped and the S/N 202 A1 unit was repaired (suspect Channel 7 DRO unit was replaced). Vibration testing was reconvened on the 20th of August 1998, with the X-axis rerun at full qualification level. A post vibration LPT was successfully run. The Y-axis vibration sequence was rerun, per NASA concurrence, with the random vibration test at acceptance level (5.3 Grms). Following a successful post Y-axis LPT, the 3rd axis (Z-axis) vibration sequence, at full qualification level, was completed. The post-vibration CPT was then successfully run, signifying the successful completion of the S/N 202 A1 vibration testing.

The vibration qualification test sequence, for each axis, per the Ref. 1 shop order was:

1. Low level sine sweep (0.25 g)
2. Sinusoidal vibration (8 g)
3. Low level sine sweep (0.25g)
4. Low level random vibration (-6 dB of full level 7.5 Grms, or 3.75 Grms)
5. Full level random vibration (7.5 Grms spec.)
6. Low level sine sweep (0.25g)
7. Acceleration/sine burst (18.75 g)
8. Low level sine sweep (0.25g)

Testing commenced on 05 August 1998 with the instrument mounted on the vibration shaker in the Ref. 3 X-axis (velocity axis) orientation (vibration in direction of the reflector shaft). The EOS testing axes were as follows:

EOS Axis	
X	Velocity Axis (Shaft)
Y	Sun Axis (Lateral)
Z	Nadir Axis (Vertical)

The following is a chronology of notes taken throughout the testing. Particular attention is paid to the motor and reflector responses, where large amplification of the input signals are found. The Ref. 5 reflector response report is used throughout for load comparisons.

X-Axis Vibration Testing

(1) Initial low level 0.25g sine sweep run 8/05/98. Triaxial responses recorded at eight locations:

(1) Upper RF shelf support, Accelerometer (Acc) 16
(2) Lower motor panel, Acc 19
(3) Lower motor housing, Acc 20
(4) Upper motor housing, Acc 22
(5) Lower RF shelf support, Acc 24A
(6) Top panel, Acc 26
(7) Lower reflector, Acc 31
(8) Upper reflector, Acc 32

In addition, for the ¼ G sine runs, transfer functions at the upper and lower motors and reflectors are plotted for the direction in-line with the test axis.

All channels reported data. The instrument fundamental frequency, f_1, was approximately 131 Hz. At the reflectors, f_1 was approximately 165 Hz. High transmissibility's were recorded at all four motor/reflector accelerometer locations, with the lower reflector most severe (Q of 71 at the lower motor and a Q of 106 at the lower reflector).

Table 1 is included to show the predicted peak 3σ loads at the motors and reflectors based on the sine sweep responses and Miles' equation, and to show comparisons (in amplification factors) with Ref. 5 reflector response tests. Note the axes differences between this writing and Ref. 5. Ref. 5 responses are put into the current (Ref. 1) coordinate system. Also note that the Ref. 5 "motor" responses are from the accelerometers mounted on the reflector hubs. Sample calculations of the predicted loads at full level (-0 dB) random vibration, using Miles' equation with low level sine sweep amplification factors are shown for Acc 20X,

$$\begin{aligned} \text{Peak } 3\sigma &= 3 \times [\, (\pi/2)(\text{PSD})(f_{ni})(Q) \,]^{1/2} \\ &= (3)\,[\, (\pi/2)\,(0.04)\,(130)\,(71) \,]^{1/2} \\ &= 72 \text{ g} \end{aligned}$$

Note that the Ref. 5 data is from the AMSU-A1 Engineering Model which is mounted via the sidemount (per NOAA K,L,M and METSAT designs). The EOS qualification instrument mounts via its baseplate. Therefore differences between Ref. 5 and the EOS instrument are to be expected. The object of the comparisons, however, is to demonstrate that the predicted peak 3σ loads in the EOS qualification unit are less than the loads experienced in previous tests. Although not shown in the sine sweep data of Table 1, the random data of Table 2 does demonstrate that appreciably higher loads were subjected to the A1 reflector in the Ref. 5 tests.

(2) Run 8g sine sweep 8/05/98. Good data. This is an EOS only requirement. The test is from 5-50 Hz. Since there are no resonant frequencies below 100 Hz, all responses are essentially the input level for in-axis, and much less at cross-axes.

(3) Run low level 0.25g sine sweep #2, 8/05/98. No significant changes from initial run. Q's recorded at 70 (lower motor at 130 Hz) and 110 (lower reflector at 169 Hz.).

(4) Low level (-6dB) random run 8/05/98. This is a 3.7 Grms run (50 % of the full level Grms). With large clearances around the A1 reflector, no gaps, other than the fore and aft clearances between the reflectors and the motor and front panels, are recorded (at start and end of each axis). A stoppage at -6 dB was made due to the large transfer functions, determined from the low level sine sweep data, at both reflectors and both motors (see Table 1).

Table 2 is developed to identify motor and reflector responses due to random vibration, predict peak 3σ loads, project peak 3σ loads to -0 dB, and compare these peak 3σ loads with Ref. 5 data, all before subjecting the EOS qualification instrument to full level random vibration. The Ref. 5 half power method is used to predict peak loads from the random vibration responses. Note the axes differences between this writing and Ref. 5. Ref. 5 responses are put into the current (Ref. 1) coordinate system. Ref. 5. data not only is from an instrument mounted differently (sidemount versus baseplate), but also is from the 8.8 Grms NOAA K,L,M random vibration spectrum. The present EOS random vibration qualification spectrum (see Table 3) is only 7.5 Grms.

From the X-Axis -6dB data, the projected maximum peak 3σ load is 89.8g at the upper reflector (with 89.0g predicted at the lower reflector). Ref. 5 determined a load of 132g for the upper reflector per same loading direction and response, and 190g in the Ref. 1 Z-axis. Likewise, the lower reflector projected 89g load compares with the Ref. 5 lower reflector 169g load per same loading direction and response, and 225g in the Ref. 1 Z-axis. Thus, it is reasonable to proceed to full level random vibration, since the projected full level loads are much less than the maximum loads already experienced in Ref. 5 (89.8g << 132g, << 190g, and 89g <<169g, << 225g).

Sample calculations for the predicted peak 0 dB load, using the 1/2 power point method, and projecting from the -6dB data, is shown for Acc 20X,

$$\text{Peak } 3\sigma = 2 \times 3 \times [(132-122)(10)]^{1/2} \quad = 60\text{g Peak at -0dB}$$

(5) Full level random (7.5 Grms) was run 8/05/98. The vibration level was increased to the full random vibration qualification level of 7.5 Grms. The test was begun, and just upon reaching full level, both accelerometers on the reflectors (31 and 32) stopped recording. All response of Acc 32 (upper reflector) at full level was lost. Response data for Acc 31 (lower reflector) was later retrieved from tape. As documented above, the responses were particularly significant at the motors and the reflectors.

The Table 2 entries for "X-Axis -0 dB" show the response data for the upper and lower motors and reflectors at full level random vibration. The lower reflector -6 dB projected full level 89g peak 3σ load calculates to 82.2g per -0 dB data. Note the Grms responses at full level are generally less than the projected 2 x response at -6 dB, indicating a measure of dampening occurring. For the upper reflector, no -0 dB response is available. A comparison of motor and reflector responses between Ref. 5 and the current EOS qualification instrument, for X-Axis loading, shows the current instrument developing peak loads of less magnitude than Ref. 5 (89.8g < << 132g, << 190g upper reflector, and 82.2g <<169g, << 225g lower reflector). Therefore, no reflector/motor vibration problems should be nor are evident.

(6) Post random low level 0.25g sine sweep, run 8/5/98. No significant change in signature.

(7) The 18.75g sine burst test was run on 8/5/98. Extensive shake witnessed and 17.7g achieved per output data. No indication of failure.

(8) The post sine burst low level 0.25g sine sweep was run on 8/5/98, and looks OK. Very little frequency degradation from the initial low level sine sweep run at the beginning of vibration testing of this axis. From sine sweep #1, with representative accelerometer 16 (at upper RF shelf support), 1st f_{n1}, f_{n2} 131, 158 Hz, to sine sweep #4, with f_{n1}, f_{n2} 128, 156 Hz., only 2-3 Hz change is seen. This is acceptable. X-axis vibration completed. Measuring of alignment after vibration shows no translation of the reflector along the drive axis.

(9) The limited performance test (LPT), post X-axis vibration, performed 8/6/98. Results identify a problem on Channel 7 where a marginal response is output (Channel 7 NEΔT read 0.447 (Requirement is < 0.25). Failure Review Board (FRB) met and drafted the Ref. 4 course of action. Per discussion with NASA, agreed to proceed with Y-axis vibration tests to help in investigation of Channel 7 problem.

Y-Axis Vibration Testing

(10) The initial Y-Axis low level 0.25g sine sweep run 8/6/98. In-line Acc 22Y (upper motor) noted f_{n1} is 147 Hz. All channels reported data, however 20Z and 26Y are erroneous. Transmissibility's recorded at the reflectors and motors are less in the Y-axis. (A maximum Q of 49 at the upper reflector is seen for the Y-axis test).

(11) 8g sine sweep run 8/06/98 with no incident.

(12) Run low level 0.25g sine sweep #2, 8/06/98. No significant changes from initial run. Q's recorded at 48 for both 31X (lower reflector) and 32Z (upper reflector).

(13) Full level random (7.5 Grms) run 8/06/98 (no stop at -6 dB for Y-axis). Table 2 entries are made. From the Y-Axis -0 dB data, the maximum calculated peak 3σ load is 114.6g at the upper reflector. Ref. 5 determined a load of 105g at the lower reflector. Responses are not comparable, per same direction and location, due to the different mounting methods. Predicted peak load level (114.6g) exceeds X-axis peak load prediction (89.8g), however, load level is less than the Ref. 5 value (224.5g) tabulated for the Ref. 1 X-axis. Thus, it is reasonable to predict no problems should be nor are evident after the Y-axis random vibration test.

(14) Post random low level 0.25g sine sweep, run 8/6/98. Some changes in signature, especially in the motor and reflector responses, primarily in the cross axes. 2 to 3 Hz relaxation in f_{n1} for 22Y and 31Y. Results of the post random sine sweep, however, are not different enough from pre-random to signify a failure. Therefore the testing continues.

(15) The 18.75g sine burst test was run on 8/6/98. Extensive shake witnessed and 17.7g achieved per output data. No indication of failure.

(16) The post sine burst low level 0.25g sine sweep was run on 8/6/98, and closely resembles the pre sine burst data. No further reduction in f_{n1} for 22Y and 31Y. Y-axis vibration completed. Measuring of alignment after vibration shows no translation of the reflector along the drive axis.

(17)The limited performance test (LPT), post Y-axis vibration, performed 8/6/98, identified a more significant problem on Channel 7, where a more marginal response than the post X-axis LPT is now output (Channel 7 warmload counts decreased further to 9500, (pre-vibration 16500 counts, post X-axis vibration, 13600 counts. NEΔT unchanged). Failure Review Board (FRB) met again, and per discussion with NASA, agreed to stop vibration at this time and repair the Channel 7 problem.

The Channel 7 problem, initially diagnosed as possibly in the waveguide attenuator, the semi-rigid cabling, the mixer/IF, and/or the DRO, was investigated at length and found to be in the DRO. The DRO was replaced, the unit reassembled, various functional tests were performed, and the unit again ready for vibration on 8/20/98.

The vibration schedule was to, (1) re-do the X-axis sequence at qualification level, (2) redo the Y-axis sequence, with the random vibration test rerun per NASA concurrence at acceptance level (5.3 Grms), then, (3) do the qualification level sequence in the Z-axis.

Repeated X-Axis Vibration Testing

(18)The instrument was mounted in the X-axis, instrumented, and readied for vibration on 8/20/98. The low level sine sweep was completed 8/20/98. Responses at the motors and reflectors identified slightly lower natural frequencies in the repeated X-axis run as compared to the initial X-axis 1st low level sine sweep. This should be expected, since the Y-axis runs above had already indicated of a slight natural frequency reduction. A tabulation of f_{n1} for the inline axis response for motors and reflectors shows

Accel	Initial X-axis Response		Repeated X-axis Response	
	f_{n1} (Hz)	Q	f_{n1} (Hz)	Q
20X	129.9	71	128.1	49
22X	132.7	65	128.1	55
31X	169.4	106	167.0	90
32X	164.6	77	152.1	48

(19) 8g sine sweep run 8/20/98 with no incident.

(20) Low level 0.25g sine sweep #2,run 8/20/98. No significant changes from 1st run. Q at lower refl. (31X) increases slightly to 92 (was 90) Response at same frequency (167 Hz).

(21) Full level random (7.5 Grms) run 8/20/98 (no stop at -6 dB). Responses are similar to the original X-axis responses. Grms level is maximum at 73.2 at the upper reflector for the repeated run. For the 1st run, (57.9 Grms at the lower reflector, no upper reflector response data) . A comparison of calculated peak 3σ loads is shown below. Generally, the initial -0 dB X-Axis run was the more responsive.

		Initial X-Axis -0 dB	**Initial X-Axis -0 dB**	**Repeated X-Axis -0 dB**	**Repeated X-Axis -0 dB**
Accel Location	Accel	Total Grms	0 dB Peak 3σ Load	Total Grms	0 dB Peak 3σ Load
Lower Motor	20X	25.4	46.5	22.3	35.5
	Y				
	Z			6.1	
Upper Motor	22X	29.8	50.7	26.5	50.2
	Y				
	Z				
Lower Refl	31X	43	82.2	40.5	66.7
	Y	31.2	8.7	22.3	8.0
	Z	57.9	52.5	54.1	42.2
Upper Refl*	32X			55.8	96.1
	Y				
	Z			73.2	55.3

* No data available for Initial X-Axis -0 dB 32X, Y, Z.

(22) Run low level 0.25g sine sweep #3, 8/20/98. No significant changes from 2nd sine sweep. Q at lower reflector (31X) at 92 (was 92). Response at same frequency (167 Hz).

(23) The 18.75g sine burst test was run on 8/20/98. High end of tolerance, with 19.17g recorded per control. No indication of failure.

(24) The post sine burst low level 0.25g sine sweep was run on 8/20/98, and closely resembles the pre sine burst data. No further reduction in f_{n1} (128 Hz at 20X, 167 Hz at 31X). X-axis vibration completed. Measuring of alignment after vibration shows no translation of the lower reflector along the drive axis, and 0.006 in drift of the upper reflector, away from the motor.

Repeated Y-Axis Vibration Testing

(25)The instrument was mounted in the Y-axis and readied for vibration on 8/21/98. The low level sine sweep was completed 8/21/98. Responses at the motors and reflectors, again, identified slightly lower natural frequencies in the repeated Y-axis run as compared to the initial Y-axis 1st low level sine sweep. A tabulation of f_{n1} for the response for motors and reflectors shows the following. Note for 32Y there are two peaks in each plot (at 145 Hz and 162 Hz). Peak 1 is the higher in the repeated run, peak 2 is higher in the initial run.

Accel	Initial Y-axis Response f_{n1} (Hz)	Initial Y-axis Response Q	Repeated Y-axis Response f_{n1} (Hz)	Repeated Y-axis Response Q
20Y	144	2.1	140	2.2
22Y	147	30	145	34
31X	168	48	167	68
31Y	168	13	167	18
31Z	168	32	167	39
32X	162	114	161	120
32Y	162	32	145	29
32Z	162	49	161	40

(26) 8g sine sweep run 8/21/98 with no incident.

(27) Run low level 0.25g sine sweep #2, 8/21/98. No significant changes from 1st run. Q at upper reflector (32X) increases slightly to 130 (was 120). Response at same freq. (162 Hz).

(28) Full level random was run at the acceptance level (5.3 Grms) run 8/21/98 (no stop at -6 dB). Responses are similar to the original Y-axis responses. Grms level is maximum at 60.3 at the lower reflector for the repeated (acceptance) run. For the 1st run, 71.2 Grms for the qualification run . A comparison of calculated peak 3σ loads is shown below. Generally, the projected -0 dB Repeated Y-Axis run was the more responsive. This is due to projecting linearly to -0 dB. Usually, more dampening will be present at the higher levels, reducing the projected peaks.

Accel Location	Accel	**Initial Y-Axis -0 dB** Total Grms	**Initial Y-Axis -0 dB** 0 dB Peak 3σ Load	**Repeated Y-Axis -3 dB** Total Grms	**Repeated Y-Axis -0 dB Projected** 0 dB Peak 3σ Load
Lower Motor	20X	12.6	10.9	7.8	12.1
	Y				
	Z				
Upper Motor	22X	17.7	30.7	11.6	26.8
	Y	17.3	45.3	13.8	48.9
	Z				
Lower Refl	31X	30.2	35.2	29.2	39.8
	Y	58.7	6.4	46.8	8.7
	Z	71.2	20.4	60.3	25.9
Upper Refl	32X	51.9	114.6	44.7	168.5
	Y	35.5	33.7	31.1	44.9
	Z	67.2	56.3	46.1	79.8

(29) Run low level 0.25g sine sweep #3, 8/21/98. There are some changes, particularly in the motors and reflectors, from the pre random sine sweep #2. Most easily seen at the upper reflector (32Y) response, there is now a slight rise in response at 126 Hz (Q = 6). Otherwise, the upper motor response (22Y) is typical, with a reduction of 1 Hz (145 to 144 Hz) at the 1st natural frequency. The Q at upper reflector (32X) decreases from 130 Hz back down to the initial sine sweep #1 value of 120 Hz. Response at same frequency (162 Hz).

(30) The 18.75g sine burst test was run on 8/21/98. High end of tolerance again, with 19.4g recorded per control. No indication of failure.

(31) The post sine burst low level 0.25g sine sweep (#4) was run on 8/21/98, and closely resembles the pre sine burst data. No further reduction in f_{n1} (144 Hz at 22Y, 168 Hz at 31Y). The response at upper reflector 32Y continues to have the slight rise at 126 Hz (Q= 6.5). Y-axis vibration completed. Measuring of alignment after vibration shows no further translation of the reflectors along the drive axis.

Z-Axis Vibration Testing

(32)The instrument was mounted in the Z-axis and readied for vibration on 8/22/98. This is the initial Z-Axis vibration. The low level sine sweep was completed 8/21/98. Responses at the motors and reflectors are seen in Table 1, where, the upper reflector 32X is shown as particularly high. Upper reflector 32X has a Q = 99.5 and a peak 3σ load projected to 94.6g.

(33) 8g sine sweep run 8/22/98 with no incident.

(34) Run low level 0.25g sine sweep #2, 8/22/98. No significant changes from 1st run. Q at upper reflector (32X) unchanged at 99.5. Response at same frequency (160 Hz).

(35) Low level (-6dB 3.7 Grms) random run 8/22/98. From Table 2, Z-Axis -6dB data, the projected (-0 dB) maximum peak 3σ load is 78.2g at the upper reflector. Ref. 5 determined a load of 54.9g for the upper reflector per same loading direction and response, and 98.7g in the Ref. 1 Z-axis. These loads are much smaller than developed/projected from the other axes. Thus, it is reasonable to proceed to full level random vibration (78.2g << 114.6g from Y-Axis vibration).

(36) Full level random (7.5 Grms) was run 8/22/98. The vibration level was increased to the full random vibration qualification level of 7.5 Grms. More dampening was present at full level, so the projected loads from the -6 dB run were not reached. The Table 2 entries for "Z-Axis -0 dB" show the response data for the upper and lower motors and reflectors at full level random vibration. The lower reflector -6 dB projected full level 78.2g peak 3σ load calculates to only 52.8g per -0 dB data. A comparison of motor and reflector responses between Ref. 5 and the current EOS qualification instrument, for Z-Axis loading, shows the current instrument developing peak loads of less magnitude than Ref. 5 (52.8g << 98.7g upper reflector). The baseplate/sidemount mounting differences are significant to the reflector response differences

between Ref. 5 and the current tests. However, response of EOS S/N 202 is minimal in this axis. Therefore, no reflector/motor vibration problems should be nor are evident.

(37) Run low level 0.25g sine sweep #3, 8/22/98. The transmissibility at the lower reflector (32Z) is decreased after the full level random vibration test, as can be seen from the table below, where sine sweep 1st natural frequencies and transmissibilities are compared for all Z-Axis sine sweeps. From the pre-random sine sweep, a Q of 32.7 at 167 Hz is seen, and from the post-random sine sweep, a Q of only 8.3 at 167 Hz is registered. The upper reflector acts to retain its transmissibility.

Z-Axis Comparison of 0.25g Low Level Sine Sweeps

Accel Location	Accel	Sine Sweep #1 Pre-8g Sine		Sine Sweep #2 Pre-Random Sine		Sine Sweep #3 Post-Random Sine		Sine Sweep #4 Post-Sine Burst	
		1st f^n (Hz)	Q	1st f^n (Hz)	Q	1st f^n (Hz)	Q	1st f^n (Hz)	Q
Lower Motor	20X								
	Y								
	Z	131.8	2.1	131.8	2.1	130.8	2.4	130.8	2.4
Upper Motor	22X								
	Y								
	Z	158.8	4.6	158.8	4.5	158.5	4.3	156.5	3.7
Lower Refl	31X								
	Y								
	Z	167	33.8	167	32.7	167	8.3	168.2	12.9
Upper Refl	32X								
	Y								
	Z	159.9	39.5	159.9	40.8	157.7	44.4	158.8	39.8
Top Panel	26X								
	Y								
	Z	159.9	0.7	159.9	0.7	157.7	0.6	157.7	0.5

(29) The 18.75g sine burst test was run on 8/22/98. High end of tolerance again, with 19.6g recorded per control. No indication of failure.

(30) The post sine burst low level 0.25g sine sweep (#4) was run on 8/22/98, and closely resembles the pre sine burst data. No further reduction of Q at the lower reflector (31Z), in fact, transmissibility, Q, is seen to increase slightly to 12.9 (was 8.3). Z-axis vibration completed. Measuring of alignment after vibration shows no further translation of either reflector along the drive axis.

RESULTS

Table 1 displays initial sine sweep data, for the motors and reflectors, for the X-axis, the repeated X-axis, the Y-axis, the repeated Y-axis, and the Z-Axis vibration sequences. In Table 1, for each accelerometer, the 1st natural frequency and transmissibility are listed, along with the PSD level of the random vibration spectrum at fn1, and the peak 3σ load (determined via Miles equation). Ref. 5 Q's are listed for comparison.

Table 2 tabulates random vibration data at the reflectors and motors. At each location, the -0 dB 3σ load is found, calculated using the half-power method on the response data. Loads per Ref. 5 are also listed for comparison purposes.

As an appendix to this report, the complete list of acceleration and power spectral density (PSD) plots at all response locations, is included.

CONCLUSIONS and RECOMMENDATIONS

The Ref. 2, S/N 202, EOS AMSU-A1 Instrument was successfully vibration tested to qualification levels per the Ref. 1 shop order. The loss of transmissibility, however, seen in the lower reflector after Z-axis random vibration, is a concern. The post-vibration comprehensive performance test (CPT) was, however, successfully run after completion of the three axes of vibration.

Transmissibility is a function of the dampening present. At the lower reflector, where Q reduced by a factor of 4, there was no degradation of natural frequency. F_{n1} held steady at 167-168 Hz. With consistent f_{n1}, there is no stiffness loss.

It is recommended to closely inspect the suspect (lower) reflector for things such as loose or missing screws, plastic deformation, cracking of the material. To demonstrate there is no significant degradation of the lower reflector assembly, a diagnostic test such as a Bode plot of the motor/reflector should be considered, with results compared to a similar test performed before random vibration.

NOTE: See Addendum A For Further Test Review.

R. J. Heffner

R. J. Heffner
Mechanical Design and Analysis

Table 1 AMSU -A1 EOS Qual Level Test Data Miles' Equation w/Low Level Sine Sweep

X-Axis 1st Sine Sweep					Random	Peak
				Ref. 5	PSD	3σ
Accel Location	Accel	1st fn	Q	Q	Level	Load
Lower Motor	20X	130	71	14	0.04	**72.2**
	Y	130	2.4	11	0.04	**13.3**
	Z	130	7	25	0.04	**22.7**
Upper Motor	22X	133	65	19	0.04	**69.9**
	Y	154	4	13	0.04	**18.7**
	Z	134	12	22	0.04	**30.2**
Lower Refl	31X	169	105.7	74	0.04	**100.5**
	Y	171	28	53	0.04	**52.0**
	Z	169	58	60	0.04	**74.5**
Upper Refl	32X	165	76.6	74	0.04	**84.5**
	Y	166	21	80	0.04	**44.4**
	Z	160	32	98	0.04	**53.8**

Y-Axis 1st Sine Sweep					Random	Peak
				Ref. 5	PSD	3σ
Accel Location	Accel	1st fn	Q	Q	Level	Load
Lower Motor	20X	130	8.0	6	0.04	**24.3**
	Y	144	2.1	15	0.04	**13.1**
	Z	170	16.0	21	0.04	**39.2**
Upper Motor	22X	168	16.0	7	0.04	**39.0**
	Y	147	30.4	31	0.04	**50.3**
	Z	148	6.0	9	0.04	**22.4**
Lower Refl	31X	168	48.0	9	0.04	**67.5**
	Y	168	13.3	100	0.04	**35.5**
	Z	168	32.0	27	0.04	**55.1**
Upper Refl	32X	162	114	15	0.04	**101.6**
	Y	162	32.0	7	0.04	**53.8**
	Z	162	49.0	20	0.04	**66.6**

Table 1 (continued)

Repeated X-Axis 1st Sine Sweep Accel Location	Accel	1st fn	Q	Ref. 5 Q	Random PSD Level	Peak 3σ Load
Lower Motor	20X	128	49.0	14	0.04	**59.6**
	Y	128	2.0	11	0.04	**12.0**
	Z	128	8.0	25	0.04	**24.1**
Upper Motor	22X	128	55.3	19	0.04	**63.3**
	Y	153	6.0	13	0.04	**22.8**
	Z	128	11.2	22	0.04	**28.5**
Lower Refl	31X	167	90.4	74	0.04	**92.4**
	Y	167	12.6	53	0.04	**34.5**
	Z	167	47.0	60	0.04	**66.6**
Upper Refl	32X	153	48.0	74	0.04	**64.4**
	Y	167	13.0	80	0.04	**35.0**
	Z	153	18.8	98	0.04	**40.3**

Repeated Y-Axis 1st Sine Sweep Accel Location	Accel	1st fn	Q	Ref. 5 Q	Random PSD Level	Peak 3σ Load
Lower Motor	20X	172	10.0	6	0.04	**31.2**
	Y	140	2.2	15	0.04	**13.2**
	Z	130	1.2	21	0.04	**9.4**
Upper Motor	22X	171	12.2	7	0.04	**34.3**
	Y	145	34.4	31	0.04	**53.1**
	Z	145	7.6	9	0.04	**25.0**
Lower Refl	31X	167	68.0	9	0.04	**80.1**
	Y	167	17.7	100	0.04	**40.9**
	Z	167	39.0	27	0.04	**60.7**
Upper Refl	32X	161	120.0	15	0.04	**104.5**
	Y	145	29.4	7	0.04	**49.1**
	Z	161	40.4	20	0.04	**60.6**

Table 1 (continued)

Z-Axis 1st Sine Sweep					Random	Peak
				Ref. 5	PSD	3σ
Accel Location	Accel	1st fn	Q	Q	Level	Load
Lower Motor	20X	131	8.1	7	0.04	**24.5**
	Y	168	1.3	5	0.04	**11.1**
	Z	132	2.1	14	0.04	**12.5**
Upper Motor	22X	170	14.8	21	0.04	**37.7**
	Y	189	12.6	9	0.04	**36.7**
	Z	159	4.6	26	0.04	**20.3**
Lower Refl	31X	167	74.0	27	0.04	**83.6**
	Y	168	11.4	55	0.04	**32.9**
	Z	167	33.8	3	0.04	**56.5**
Upper Refl	32X	159	99.5	79	0.04	**94.6**
	Y	169	12.5	48	0.04	**34.6**
	Z	160	39.5	97	0.04	**59.8**

Table 2 AMSU -A1 EOS Qual Level Test Data 1/2 Power Points

X-Axis -6 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	-6 dB Peak 3σ Load	Projected 0 dB Peak 3σ Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	15.7	0.2895	0.4167	122	132	10	10.0	**30.0**	**60.0**	**55.8**
	Y										**45.8**
	Z										**16.3**
Upper Motor	22X	17.7	0.3158	0.4474	124	136	11	11.5	**34.5**	**68.9**	**62.6**
	Y										**35.9**
	Z										**35.9**
Lower Refl	31X	25.5	0.7035	0.7895	163	173	22	14.8	**44.5**	**89.0**	**169.1**
	Y	13.9	0.7137	0.8062	164	175	1	3.3	**9.9**	**19.9**	**126.6**
	Z	37.2	0.7080	0.8097	163	175	10	11.0	**32.9**	**65.7**	**224.5**
Upper Refl	32X	29.4	0.5614	0.6974	148	162	16	15.0	**44.9**	**89.8**	**132.3**
	Y	23.3	0.6740	0.8414	160	179	0.41	2.8	**8.4**	**16.7**	**101.8**
	Z	40.9	0.5702	0.8673	148	182	5	13.0	**39.1**	**78.2**	**190.4**

X-Axis -0 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	0 dB Peak 3σ Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	25.4	0.2646	0.4036	120	132	20	15.5	**46.5**	**55.8**
	Y									**45.8**
	Z									**16.3**
Upper Motor	22X	29.8	0.3000	0.4405	123	136	22	16.9	**50.7**	**62.6**
	Y									**35.9**
	Z									**35.9**
Lower Refl	31X	43	0.6608	0.7930	158	173	50	27.4	**82.2**	**169.1**
	Y	31.2	0.7137	0.8194	164	176	0.7	2.9	**8.7**	**126.6**
	Z	57.9	0.6550	0.8026	157	174	18	17.5	**52.5**	**224.5**
Upper Refl	32X			No data available At 0 dB					**89.8**	**132.3**
	Y			Peak is scaled per -6 dB data.					**16.7**	**101.8**
	Z								**78.2**	**190.4**

Table 2 AMSU -A1 EOS Qual Level Test Data 1/2 Power Points

Y-Axis -0 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	0 dB Peak G Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	12.6	0.2920	0.3628	122	129	1.9	3.6	**10.9**	**6.3**
	Y									**14.1**
	Z									**4**
Upper Motor	22X	17.7	0.3568	0.5133	128	143	7.0	10.2	**30.7**	**3.3**
	Y	17.3	0.4248	0.5991	134	151	13.4	15.1	**45.3**	**15.2**
	Z									**5**
Lower Refl	31X	30.2	0.6549	0.7577	157	169	11.5	11.7	**35.2**	**31.6**
	Y	58.7	0.6770	0.7621	160	170	0.46	2.1	**6.4**	**23.9**
	Z	71.2	0.6608	0.7577	158	169	4.2	6.8	**20.4**	**104.8**
Upper Refl	32X	51.9	0.4934	0.7181	141	164	63.4	38.2	**114.6**	**11**
	Y	35.5	0.4159	0.5929	133	151	7.0	11.2	**33.7**	**22.7**
	Z	67.2	0.5531	0.7522	147	168	16.8	18.8	**56.3**	**22.6**

Repeated Y-Axis -3 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	-3 dB Peak G Load	Projected 0 dB Peak 3σ Load	Ref. 5 0 dB Peak 3σ Ld
Lower Motor	20X	7.8	0.2996	0.3965	123	132	0.9	2.8	**8.5**	**12.1**	**6.3**
	Y										**14.1**
	Z										**4**
Upper Motor	22X	11.6	0.3040	0.5286	123	144	1.9	6.3	**18.9**	**26.8**	**3.3**
	Y	13.8	0.4493	0.5947	137	151	9.5	11.5	**34.6**	**48.9**	**15.2**
	Z										**5**
Lower Refl	31X	29.2	0.6608	0.7533	158	169	8.0	9.4	**28.1**	**39.8**	**31.6**
	Y	46.8	0.6696	0.7797	159	172	0.32	2.0	**6.1**	**8.7**	**23.9**
	Z	60.3	0.6608	0.7621	158	170	3.1	6.1	**18.3**	**25.9**	**104.8**
Upper Refl	32X	44.7	0.4978	0.7357	141	166	63.1	39.7	**119.2**	**168.5**	**11**
	Y	31.1	0.4469	0.5885	136	150	8	10.6	**31.7**	**44.9**	**22.7**
	Z	46.1	0.5374	0.7709	145	171	13.6	18.8	**56.4**	**79.8**	**22.6**

Table 2 AMSU -A1 EOS Qual Level Test Data 1/2 Power Points

Repeated X-Axis -0 dB Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	0 dB Peak 3σ Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	22.3	0.2611	0.354	120	128	17.5	11.8	**35.5**	**55.8**
	Y									**45.8**
	Z	6.1								**16.3**
Upper Motor	22X	26.5	0.2687	0.4317	121	135	20	16.7	**50.2**	**62.6**
	Y									**35.9**
	Z									**35.9**
Lower Refl	31X	40.5	0.6564	0.7577	158	169	45	22.2	**66.7**	**169.1**
	Y	22.3	0.6608	0.8194	158	177	0.37	2.7	**8.0**	**126.6**
	Z	54.1	0.6564	0.7665	158	170	16.5	14.1	**42.2**	**224.5**
Upper Refl	32X	55.8	0.4646	0.7965	138	174	28.5	32.0	**96.1**	**132.3**
	Y									**101.8**
	Z	73.2	0.5374	0.837	145	179	10	18.4	**55.3**	**190.4**

Table 2 AMSU -A1 EOS Qual Level Test Data 1/2 Power Points

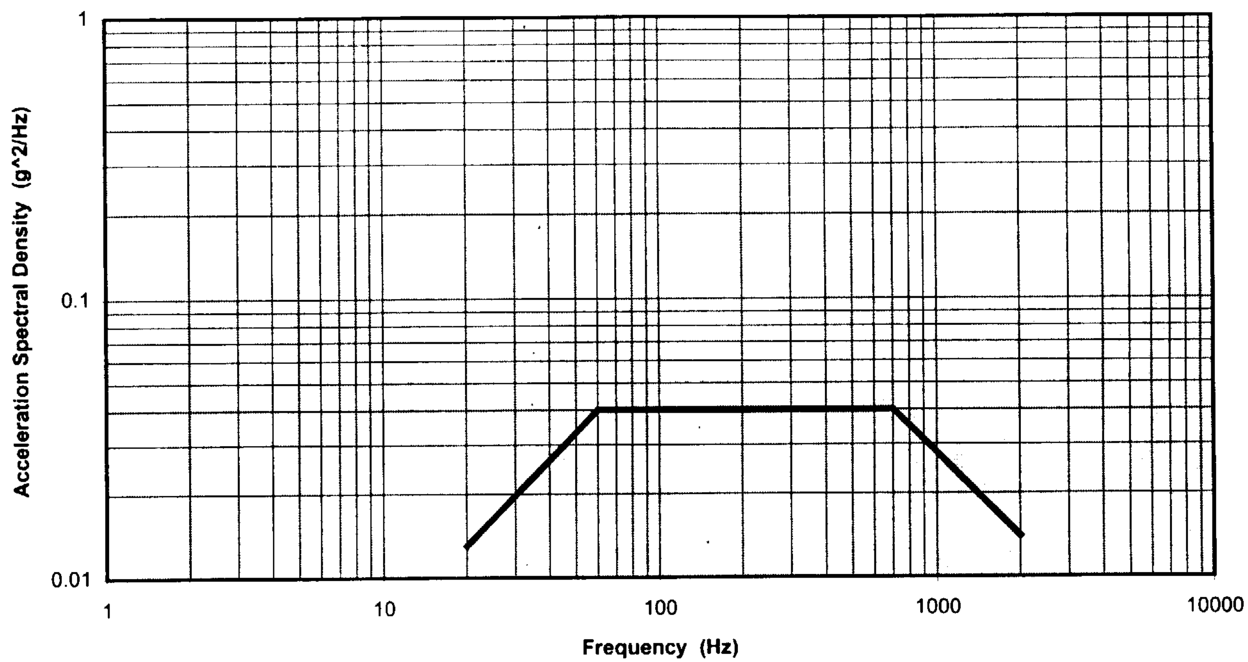
Z-Axis -6 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	-6 dB Peak G Load	Projected 0 dB Peak 3σ Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	9.8	0.3084	0.4185	124	134	0.15	1.22	**3.7**	**7.3**	**13.9**
	Y										**7.7**
	Z										**5.4**
Upper Motor	22X	8.1	0.7049	0.9333	163	191	0.35	3.13	**9.4**	**18.8**	**16.6**
	Y										**13.9**
	Z										**27.4**
Lower Refl	31X	31.2	0.6564	0.7533	158	169	4	6.63	**19.9**	**39.8**	**22.3**
	Y										**35.7**
	Z										**3.9**
Upper Refl	32X	20.7	0.6212	0.7137	154	164	17	13.04	**39.1**	**78.2**	**54.9**
	Y										**58.8**
	Z	36.0	0.6212	0.7224	154	165	3.3	6.02	**18.1**	**36.1**	**98.7**

Z-Axis -0 dB

Accel Location	Accel	Total Grms	linear 1st fn low	linear 1st fn high	1st fn low	1st fn high	1st Res G^2/Hz	1st Res Pk Grms	0 dB Peak G Load	Ref. 5 0 dB Peak 3σ Load
Lower Motor	20X	17.9	0.3040	0.4009	123	132	0.44	1.99	**6.0**	**13.9**
	Y									**7.7**
	Z									**5.4**
Upper Motor	22X	15.9	0.7049	0.8811	163	184	0.7	3.83	**11.5**	**16.6**
	Y									**13.9**
	Z									**27.4**
Lower Refl	31X	43.9	0.6858	0.7522	161	168	5	5.92	**17.7**	**22.3**
	Y									**35.7**
	Z									**3.9**
Upper Refl	32X	51.7	0.6167	0.7093	153	163	31	17.61	**52.8**	**54.9**
	Y									**58.8**
	Z	75.9	0.6167	0.7357	153	165	6.1	8.56	**25.7**	**98.7**

Table 4 New EOS Qualification Level Random Vibration (7.5 Grms)



Frequency (Hz)	Acceleration Spectral Density (g^2/Hz)
20	0.0133
20 to 60	+3 dB/Octave
60 to 700	0.04
700 to 2000	-3 dB/Octave
2000	0.014

C:\My Documents\amsua1\a1vib-sn202-98#604.doc
C:\My Documents\amsua1\eosa1.sn202.xls

GENCORP
AEROJET

Addendum A

INTEROFFICE MEMO

TO: L. T. Paliwoda

DATE: 4-Dec-1998
a1vib-sn202-rev.doc
170:8411#98-859

FROM: R. J. Heffner

SUBJECT: AMSU-A1 EOS Instrument (S/N 202) Qualification Vibration Test Review

COPIES TO: J. .A. Alvarez, D. H. Brest, J. L. Cavanaugh, D. B. Chi, R. V. Hauerwass, D. L. Tran, Writer, File

REFERENCES:

1 "Advanced Microwave Sounding Unit-A1 (AMSU-A1) Instrument Assembly EOS Qualification Level Vibration Testing", Shop Order 565632 (OC-417), July 1998.
2. "EOS/AMSU Assy, A1", Dwg. 1356008.
3. "Vibration and Sine Burst Qualification and Acceptance Test Procedure for the AMSU-A System", Aerojet Process Specification AE-26151/1C, 1 July 1998.
4. "Failure Review Board (FRB) Meeting Held 8/07/98 (F/AR 133)", IOM 6060/98#596, Channel 7 Degradation, E. J. Lorentz.
5. "Test Report - AMSU-A1 Engineering Model Reflector Response Tests", Report No. 10418, February 1994.
6. "AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August 1998 (S/O 565632, OC-417)", 170:8411#98-604, R. J. Heffner, 10 Nov. 1998.

PURPOSE

The purpose of this memo is to present information on the additional vibration testing and inspections performed on the S/N 202 AMSU-A1 Ref. 2 instrument after its August 1998 qualification level vibration testing (Ref. 6).

SUMMARY

The Ref. 2, S/N 202, EOS AMSU-A1 Instrument was vibration tested to qualification levels in Aug. 1998, per the Ref. 1 shop order. The instrument withstood the 8g sine sweep test, the 7.5 Grms random vibration test, and the 18.75g sine burst test in each of the three orthogonal axes. Some apparent loss of transmissibility, however, was seen in the lower reflector after Z-axis (3rd and last axis) random vibration.

DISCUSSION

EOS qualification level testing was performed on the S/N 202 A1 assembly during the month of August, 1998. The Z-axis full level random vibration spectrum (7.5 Grms) was run 8/22/98. The low level 0.25g sine sweep #3 was run shortly thereafter. The transmissibility at the lower reflector (31Z) decreased after the full level random vibration test, as can be seen from the table below, where sine sweep 1st natural frequencies and transmissibilities are compared for all Z-axis sine sweeps. From the pre-random sine sweep, a Q of 32.7 at 167 Hz is seen, and from the post-random sine sweep, a Q of only 8.3 at 167 Hz is registered. The upper reflector acts to retain its transmissibility.

An investigation into the lower reflector's apparent loss of transmissibility was made with results showing:

(1) The transmissibility loss was not the fault of mis-calibrated instrumentation. Instrumentation was checked and post-random low level sine sweep response were obtained from the saved tape of the load case, with results similar to the original plots. The post random sine sweep still showed a reduced transmissibility.
(2) The transmissibility loss was not the fault of the loss of preload (loosening) of any of the inspected attachment screws. After an added low level sine sweep, run in Nov. 1998, the hub-clamp screw was inspected at > 32 in-lb torque (req. 30-32 in-lb torque), the motor mount screws inspected at > 14 in-lb (req. 12-14 in-lb. torque), the balance weight to shroud attachment inspected at 1 in-lb torque (req. 13 to 16 in-oz). The two shroud plate screws were verified as having their heads spot bonded. The two visible reflector to secondary shroud screws were verified as having solithane in their joints.
(3) All low level sine sweeps performed after the Z-axis qualification level random vibration indicate a loss of transmissibility from the sine sweeps run before the Z-axis qualification random vibration. The Q level before the Z-axis qualification full level random vibration was 30 to 35. The Q level after the Z-axis qualification full level random vibration was 8 to 15. Re-testing of the instrument for Z-axis low level sine sweep in November 1998 still showed the low (Q of 12 to 15) response at the lower reflector.
(4) Inspection of the rivets showed one rivet pair connecting the shroud to the 1331373-2 support that was slightly loosened, allowing the shroud to flex at the rivet joint. This suspect rivet pair is located at 3 o'clock in the 1355777 Reflector Assy - A1, page 1, isometric view (2nd rivet pair up from the shroud plate). The lower reflector's accelerometer is located directly below the loosened rivet pair.

AMSU-A1 EOS S/N 202 Z-Axis Comparison of 0.25g Low Level Sine Sweeps

AMSU-A1 EOS S/N 202 Z-Axis Comparison of 0.25g Low Level Sine Sweeps

Accel Location	Accel	Sine Sweep #1 Pre-8g Sine 1st fn (Hz)	Q	Sine Sweep #2 Pre-Random Sine 1st fn (Hz)	Q	Sine Sweep #3 Post-Random Sine 1st fn (Hz)	Q	Sine Sweep #4 Post-Sine Burst 1st fn (Hz)	Q	Sine Sweep #5 11/98 Re-evaluate 1st fn (Hz)	Q	After Torque Check Sine Sweep #6 11/98 Re-evaluate 1st fn (Hz)	Q
Lower Motor	20X												
	Y												
	Z	131.8	2.1	131.8	2.1	130.8	2.4	130.8	2.4	131.8	1.7	131.8	1.8
Upper Motor	22X												
	Y												
	Z	158.8	4.6	158.8	4.5	158.5	4.3	156.5	3.7				
Lower Refl	31X												
	Y												
	Z	167	$\boxed{33.8}$	167	$\boxed{32.7}$	167	$\boxed{8.3}$	168.2	$\boxed{12.9}$	168.2	$\boxed{14.5}$	167.0	$\boxed{12.1}$
Upper Refl	32X												
	Y												
	Z	159.9	39.5	159.9	40.8	157.7	44.4	158.8	39.8				
Top Panel	26X												
	Y												
	Z	159.9	0.7	159.9	0.7	157.7	0.6	157.7	0.5				

The post sine burst low level 0.25g sine sweep #4 was run on 8/22/98, and closely resembles the pre sine burst data (post random sine sweep #3) with the Q at the lower reflector (31Z) seen to increase slightly to 12.9 (was 8.3).

Subsequent re-instrumentation and re-mounting of the instrument onto the shaker, and re-testing the low level sine sweep (in Z-axis) shows a continuation of low transmissibilities (Q of 14.5 before torque measurements, Q=12.1 after torque checks).

CONCLUSIONS and RECOMMENDATIONS

The Ref. 2, S/N 202, EOS AMSU-A1 Instrument was successfully vibration tested to qualification levels per the Ref. 1 shop order. The post-vibration comprehensive performance test (CPT) was successfully run after completion of the three axes of vibration. The loss of transmissibility, however, seen in the lower reflector after Z-axis random vibration, was a concern, causing additional diagnostic testing and inspections. The added testing and inspections, however, failed to identify any anomalies in the hardware.

Transmissibility is a function of the dampening present. At the lower reflector, where Q reduced by a factor of greater than 2, there was never a degradation of natural frequency. F_{n1} held steady at 167-168 Hz. With consistent f_{n1}, there is no stiffness loss. The apparent increase in dampening at the 160 to 170 Hz frequency level, would therefore be considered the result of a slight redistribution of the structure. Indeed, with the numerous riveted and screwed joints in the reflector assembly, a minor redistribution or relaxation of structure is a strong possibility, and as noted above, one slightly loosened rivet pair was noted. With the subsequent low level sine sweeps (Nov. 1998) indicating no further loss of response (indeed, the measured Q's of 14.5 and 12.1 were somewhat higher than the post random vibration sine sweep of August 1998, with Q of 8.3), and the post-test reflector inspection indicating no anomalies other than the one slightly loosened rivet pair, it is recommended to accept the S/N 202 AMSU-A1 instrument for flight use. NASA concurrence on the disposition of the S/N 202 AMSU-A1 instrument has been obtained.

R J Heffner

R. J. Heffner
Mechanical Design and Analysis

C:\My Documents\amsua1\a1vib-sn202-rev-98#859.doc
C:\My Documents\amsua1\eosa1.sn202.xls

NASA
National Aeronautics and Space Administration

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
---	---	---

4. Title and Subtitle	5. Report Date
Integrated Advanced Microwave Sounding Unit-A (AMSU-A), Engineering Test Report	10 November1998
	6. Performing Organization Code: ---
7. Author(s): R. Heffner	8. Performing Organization Report No.: 11318
	10. Work Unit No.: ---
9. Performing Organization Name and Address: Aerojet, 1100 W. Hollyvale, Azusa, CA 91702	11. Contract or Grant No.: NAS 5-32314
12. Sponsoring Agency Name and Address: NASA, Goddard Space Flight Center, Greenbelt, Maryland 20771	13. Type of Report and Period Covered: Final
	14. Sponsoring Agency Code: ---

15. Supplementary Notes

---

16. ABSTRACT (*Maximum 200 words*)

This is the Engineering Test Report, AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August/September 1998 (S/O 565632, OC-417), for the Integrated Advanced Microwave Sounding Unit-A (AMSU-A).

17. Key Words (Suggested by Author(s))	18. Distribution Statement
EOS Microwave System	Unclassified --- Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified		---

NASA FORM 1626 OCT 86

PREPARATION OF THE REPORT DOCUMENTATION PAGE

The last page of a report facing the third cover is the Report Documentation Page, RDP. Information presented on this page is used in announcing and cataloging reports as well as preparing the cover and title page. Thus, it is important that the information be correct. Instructions for filing in each block of the form are as follows:

Block 1. Report No. NASA report series number, if preassigned.

Block 2. Government Accession No. Leave blank.

Block 3. Recipient's Catalog No.. Reserved for use by each report recipient.

Block 4. Title and Subtitle. Typed in caps and lower case with dash or period separating subtitle from title.

Block 5. Report Date. Approximate month and year the report will be published.

Block 6. Performing Organization Code . Leave blank.

Block 7. Authors. Provide full names exactly as they are to appear on the title page. If applicable, the word editor should follow a name.

Block 8. Performing Organization Report No. NASA installation report control number and, if desired, the non-NASA performing organization report control number.

Block 9. Performing Organization Name and Address. Provide affiliation (NASA program office, NASA installation, or contractor name) of authors.

Block 10. Work Unit No. Provide Research and Technology Objectives and Plants (RTOP) number.

Block 11. Contract or Grant No. Provide when applicable.

Block 12. Sponsoring Agency Name and Address. National Aeronautics and Space Administration, Washington, D.C. 20546-0001. If contractor report, add NASA installation or HQ program office.

Block 13. Type of Report and Period Covered. NASA formal report series; for Contractor Report also list type (interim, final) and period covered when applicable.

Block 14. Sponsoring Agency Code. Leave blank.

Block 15. Supplementary Notes. Information not included elsewhere: affiliation of authors if additional space is required for Block 9, notice of work sponsored by another agency, monitor of contract, information about supplements (file, data tapes, etc.) meeting site and date for presented papers, journal to which an article has been submitted, note of a report made from a thesis, appendix by author other than shown in Block 7.

Block 16. Abstract. The abstract should be informative rather than descriptive and should state the objectives of the investigation, the methods employed (e.g., simulation, experiment, or remote sensing), the results obtained, and the conclusions reached.

Block 17. Key Words. Identifying words or phrases to be used in cataloging the report.

Block 18. Distribution Statement. Indicate whether report is available to public or not. If not to be controlled, use "Unclassified-Unlimited." If controlled availability is required, list the category approved on the Document Availability Authorization Form (see NHB 2200.2, Form FF427). Also specify subject category (see "Table of Contents" in a current issue of STAR) in which report is to be distributed.

Block 19. Security Classification (of the report). Self-explanatory.

Block 20. Security Classification (of this page). Self-explanatory.

Block 21. No. of Pages. Count front matter pages beginning with iii, text pages including internal blank pages, and the RDP, but not the title page or the back of the title page.

Block 22. Price Code. If Block 18 shows "Unclassified-Unlimited," provide the NTIS price code (see "NTIS Price Schedules" in a current issue of STAR) and at the bottom of the form add either "For sale by the National Technical Information Service, Springfield, VA 22161-2171" or "For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-0001," whichever is appropriate.

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

Integrated Advanced Microwave Sounding Unit-A (AMSU-A), Engineering Test Report

5. FUNDING NUMBERS

NAS 5-32314

6. AUTHOR(S)

R. Heffner

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Aerojet
1100 W. Hollyvale
Azusa, CA 91702

8. PERFORMING ORGANIZATION REPORT NUMBER

11318
10 November 1998

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

NASA
Goddard Space Flight Center
Greenbelt, Maryland 20771

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

---

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

---

13. ABSTRACT (*Maximum 200 words*)

This is the Engineering Test Report, AMSU-A1 EOS Instrument (S/N 202) Qualification Level Vibration Tests of August/September 1998 (S/O 565632, OC-417) for the Integrated Advanced Microwave Sounding Unit-A (AMSU-A).

14. SUBJECT TERMS

EOS
Microwave System

15. NUMBER OF PAGES

16. PRICE CODE

---

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filing in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

Block 1. Agency Use Only (*Leave blank*)

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g., 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g., 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, report the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	-	Contract	PR	-	Project
G	-	Grant	TA	-	Task
PE	-	Program Element	WU	-	Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Reports Number. (*if known*).

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with ...; Trans. of ...; To be published in ... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12.a Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g., NOFORN, REL, ITAR).

DOD - See DoDD 5230.24 *Distribution Statement on Technical Documents*
DOE - See authorities.
NASA - See Handbook NHB 2200.2.
NTIS - Leave blank.

Block 12.b Distribution Code.

DOD - Leave blank.
DOE - Enter DOE distribution categories from the standard Distribution for Unclassified Scientific and Technical Reports.
NASA - Leave blank.
NTIS - Leave blank.

Block 13. Abstract. Include a brief (*Maximum 200 words*) factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code (*NTIS only*).

Block 17 - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

Standard Form 298 Back (Rev. 2-89)

GENCORP
AEROJET

DOCUMENT APPROVAL SHEET

TITLE	DOCUMENT NO.
Engineering Test Report AMSU-A1 EOS Instrument(S/N 202) Qualification Level Vibration Tests of August/September 1998 (S/O 565632, OC-417) Plus Addendum A	Report 11318 10 November 1998

INPUT FROM:	DATE	CDRL:	SPECIFICATION ENGINEER:	DATE
R. Heffner		307	N/A	

CHECKED BY:	DATE	JOB NUMBER:	DATE
N/A		N/A	

APPROVED SIGNATURES	DEPT. NO.	DATE
Product Team Leader (L. Paliwoda) Jay Paliwoda	7888	12/4/98
Systems Engineer (R. Platt) P. K. Patel	8341	12/4/98
Design Assurance (E. Lorenz) E. Lorenz	8331	12/4/98
Quality Assurance (R. Taylor) R M Taylor	7831	12-7-98
Technical Director/PMO (R. Hauerwaas) R V Hauerwaas	4001	12/7/98
Released: Configuration Management (J. Cavanaugh) J. Cavanaugh	8361	12/7/98

By my signature, I certify the above document has been reviewed by me and concurs with the technical requirements related to my area of responsibility.

(Data Center) FINAL

Please return this sheet and the reproducible master to Jim Kirk (Bldg. 1/Dept. 8631), ext. 2081.